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$$\text{Similarly, } 2\int \cos^2\tfrac{1}{2}z\,d\varphi = -\psi\cos x + 2\tan^{-1}\left(\frac{\sin\frac{1}{2}(y+x)\tan\frac{1}{2}\psi}{\sin\frac{1}{2}(y-x)}\right).$$

$$\int \cos z\,d\psi = \int(\cos x\cos y + \sin x\sin y\cos\psi)\,d\psi = \psi\cos x\cos y + \sin x\sin y\sin\psi.$$

When $z=x+y$, $\theta=\varphi=0$, $\psi=\pi$; when $z=x-y$, $\theta=\psi=0$, $\theta=\pi$; when $z=y-x$, $\varphi=\psi=0$, $\theta=\pi$.

$$\therefore\ \triangle = \tfrac{1}{2}\pi r^2 \int_0^{\frac{1}{2}\pi}\left[\int_0^x (3+\cos x\cos y-\cos x-\cos y)\,dy\right.$$

$$\left. + \int_x^{\frac{1}{2}\pi}(3+\cos x\cos y-\cos x-\cos y)\,dy\right]dx.$$

$$\therefore\ \triangle = \tfrac{1}{2}\pi r^2 \int_0^{\frac{1}{2}\pi}\int_0^{\frac{1}{2}\pi}(3+\cos x\cos y-\cos x-\cos y)\,dx\,dy$$

$$= \tfrac{1}{4}\pi r^2 \int_0^{\frac{1}{2}\pi}(3\pi+2\cos x-\pi\cos x-2)\,dx = \tfrac{1}{8}\pi r^2(3\pi^2+4-4\pi)$$

129. Proposed by J. K. ELLWOOD, Principal of Colfax School, Pittsburg, Pa.

A and B play with two dice, A throwing. If he throws 7 or 11, he wins; if he throws 3, or two aces, or two sixes, B wins. But if he throws 4, 5, 6, 8, 9, or 10, he continues throwing to duplicate this throw, in which event he wins; if in throwing, however, he throws 7, B wins. What is the expectancy of each? [This is the regulation "crap" game, B being banker.]

Solution by G. B. M. ZERR, A..M., Ph.D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

The chance of throwing 7 or 11 is $\frac{2}{9}$; the chance of throwing 2, 3, or 12 is $\frac{1}{9}$; the chance of throwing 4, 5, 6, 8, 9, or 10 is $\frac{2}{3}$. If A throws 4 the first throw the chance of winning the second throw is $\frac{1}{12}.\frac{2}{3}$; of winning the third throw is $\frac{1}{12}.\frac{2}{3},[1-(\frac{1}{12}+\frac{1}{6})]=\frac{1}{12}.\frac{2}{3}.\frac{3}{4}$.

$\therefore$ A's chance of winning on 4 is $\frac{2}{9}+\frac{1}{12}.\frac{2}{3}[1+\frac{3}{4}+(\frac{3}{4})^2+(\frac{3}{4})^3+....]=\frac{4}{9}$.

A's chance of winning on 5 is $\frac{2}{9}+\frac{1}{9}.\frac{2}{3}[1+\frac{13}{18}+(\frac{13}{18})^2+(\frac{13}{18})^3+.,..]=\frac{22}{45}$.

A's chance of winning on 6 is $\frac{2}{9}+\frac{5}{36}.\frac{2}{3}[1+\frac{25}{36}+(\frac{25}{36})^2+(\frac{25}{36})^3+....]=\frac{52}{99}$.

A's chance of winning on 8, 9, or 10 is the same as for 6, 5, or 4.

$\therefore$ A's chance$=\frac{1}{3}(\frac{4}{9}+\frac{22}{45}+\frac{52}{99})=\frac{722}{1485}$; B's chance$=1-\frac{722}{1485}=\frac{763}{1485}$.

If the wager is given their expectation follows at once.

Also solved, with different results, by *W. W. LANDIS*.

MISCELLANEOUS.

128. Proposed by J. E. SANDERS, Hackney, O.

The sides of a trapezium are $a=29$, $b=32$, $c=40$, and $d=36$. If c is opposite a, and the diagonals equal, what is the length of either diagonal?